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Regular and stochastic behavior of Parkinsonian pathological tremor signals

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Abstract

Regular and stochastic behavior in the time series of Parkinsonian pathological tremor velocity is studied on the basis of the statistical theory of discrete non-Markov stochastic processes and flicker-noise spectroscopy. We have developed a new method of analyzing and diagnosing Parkinson's disease (PD) by taking into consideration discreteness, fluctuations, long- and short-range correlations, regular and stochastic behavior, Markov and non-Markov effects and dynamic alternation of relaxation modes in the initial time signals. The spectrum of the statistical non-Markovity parameter reflects Markovity and non-Markovity in the initial time series of tremor. The relaxation and kinetic parameters used in the method allow us to estimate the relaxation scales of diverse scenarios of the time signals produced by the patient in various dynamic states. The local time behavior of the initial time correlation function and the first point of the non-Markovity parameter give detailed information about the variation of pathological tremor in the local regions of the time series. The obtained results can be used to find the most effective method of reducing or suppressing pathological tremor in each individual case of a PD patient. Generally, the method allows one to assess the efficacy of the medical treatment for a group of PD patients.

Keywords: Discrete non-Markov processes; Flicker-noise spectroscopy; Time-series analysis; Parkinson's disease; Complex systems

1. Introduction. Parkinson's disease

Recently, much effort has been made in searching new alternative methods of diagnosing, treating and preventing severe diseases of central nervous and locomotor systems. Among them, Parkinson's disease (PD) is one of the most serious illnesses. PD, was called so by the French neurologist Pierre Marie Charcot in the 19th century to honor Dr. James Parkinson, who first described the disease in 1817. Dr. Parkinson presented the account of the observation results made, about six patients in his book *An essay on the shaking palsy*.

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